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### (54) Method of manufacturing laminated thermoplastic resin sheet and apparatus therefor

(57) A method of manufacturing a laminated thermoplastic resin sheet having an improved transparency without generating a wrinkle and an apparatus therefor are provided. The laminated thermoplastic resin sheet is manufactured by using an apparatus comprising an endless belt wound between a first cooling roll (13) having an elastic material (18) and a second cooling roll (14) and a third cooling roll (16) brought into contact with the first cooling roll through the belt (15), arranging a guide roll (21) near the first roll (13) so as to introduce a molten thermoplastic resin sheet (11) between the first and third cooling rolls (13, 16) in such a manner as to be brought into contact with the belt contact with the first cooling roll and the third cooling roll substantially at the same time, and introducing a thermoplastic resin film (22) between the belt (15) and the third cooling roll (16) through the guide roll (24).

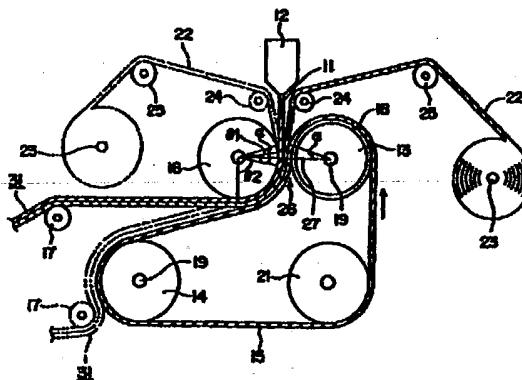


Figure 1

**Description****BACKGROUND OF THE INVENTION****5 Field of the Invention**

[0001] The present invention relates to a method of manufacturing a thermoplastic resin sheet having a laminated structure and an apparatus therefor, and an obtained sheet can be used for packaging food products, medical and pharmaceutical products and the like.

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**Description of the Related Art**

[0002] A laminated thermoplastic resin sheet obtained by laminating a function film which applies an easy slipping characteristic, an oxygen barrier characteristic and the like to a base material sheet made of a polypropylene or the like is used in a field of food products and the like.

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[0003] The easily slipping film includes a non oriented polypropylene film and the like, and the oxygen barrier film includes an EVOH film and the like.

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[0004] Conventionally, such a laminated thermoplastic resin sheet is manufactured by a coextrusion method, a dry laminate method or the like.

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[0005] However, in the case of the coextrusion method, since an adhesive layer having a certain thickness or more is required between the base material sheet and the function film, the adhesive layer prevents a transparency. Further, it is hard to manufacture a multiple layer sheet made of resins having different melting characteristics with increasing a transparency. Still further, since a rate of an edge portion of the sheet to be trimmed is relatively large, a cost loss is increased in the case that the function film is expensive such as the EVOH film.

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[0006] On the contrary, in the case of the dry laminate method, since the sheet and the film are bonded to each other through an adhesive, an amount of the adhesive is increased, so that a cost is increased, when the thickness of the sheet becomes thick due to an increase of a number of the layers. Since a solvent is contained in the adhesive, a countermeasure on an environment is necessary.

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**SUMMARY OF THE INVENTION**

[0007] Accordingly, an object of the present invention is to provide a method of manufacturing a laminated thermoplastic resin sheet having an improved transparency without generating a wrinkle, and an apparatus therefor.

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[0008] In accordance with a first aspect of the present invention, there is provided a method of manufacturing a laminated thermoplastic resin sheet, which uses a manufacturing apparatus comprising a first cooling roll having a surface coated by an elastic material, a second roll, a metal endless belt wound between the first roll and the second roll and a third cooling roll brought into contact with the first cooling roll through the metal endless belt, comprising steps of arranging a guide roll for introducing a film near the first or third roll so as to introduce a thermoplastic resin sheet in a melting state between the first and third cooling rolls in such a manner as to be brought into contact with the metal endless belt supported by the first cooling roll and the third cooling roll substantially at the same time, introducing a thermoplastic resin film between the metal endless belt and the third cooling roll through the guide roll so as to laminate the sheet and the film, pressing and cooling the laminated thermoplastic resin sheet in a plane manner by the first and third rolls while elastically deforming the elastic material by a pressing force between the first and third rolls, and continuously pressing and cooling the laminated thermoplastic resin sheet to the third cooling roll in a plane manner by the endless belt.

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[0009] In accordance with the present invention, it is preferable that the metal endless belt and the rolls are formed in a mirror surface having a surface roughness 0.5 S or less.

[0010] A stainless steel, a carbon steel, a titan alloy and the like can be used for a material of the metal endless belt. A thickness of the endless belt can be optionally selected, however, from the view point of the belt strength 0.3 mm or more is preferable.

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[0011] In this case, it is sufficient that at least the first cooling roll and the second roll are situated at the inside of the endless belt, and the other rolls for adjusting a tension and for cooling in an auxiliary manner may be included.

[0012] A fluorine rubber, a silicone rubber, an EPDM, an NBR and the like can be used for a material of the elastic material. Further, it is preferable to set a thickness of the elastic material to be 3 mm or more for obtaining an improved plane pressure by an elastic deformation.

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[0013] The thermoplastic resin sheet in the melting state corresponds to, for example, a thermoplastic resin sheet immediately after being extruded from a T die of an extruding machine.

[0014] The thermoplastic resin sheet becomes a base material sheet, and a material thereof can be optionally

selected, among a polyethylene, a polypropylene, a polystyrene, a nylon and the like.

[0015] The thermoplastic resin film corresponds to, for example, a formed film fed out from a film supply roll. The thermoplastic resin film corresponds to a function film applying functions such as an easy slipping characteristic, an oxygen barrier characteristic and the like to the base material sheet. For example, in the case of the easily slipping film, a non oriented polypropylene film or the like is employed, and in the case of the oxygen barrier film, an EVOH film is employed.

5 [0016] The thermoplastic film may have a multiple layer structure, for example, a two layer structure comprising EVOH layer/PP layer, and a three layer structure comprising PP layer/EVOH layer/PP layer.

[0017] A thickness of the thermoplastic resin film can be optionally selected, however, 10 to 1000  $\mu\text{m}$  is preferable. Cooling means may be provided in the first to third rolls.

10 [0018] In the present invention, since the thermoplastic resin sheet and film are relatively different from each other only in view of a thickness, any of them may be called as the sheet or the film.

[0019] In accordance with the present invention, the sheet and the film are pressed and laminated in a plane manner together with an elastic deformation of the elastic material, a bonding strength between the laminated sheets is improved, and a rate of shrinkage at a time of laminating can be controlled within a certain small range.

15 [0020] Further, at a time of laminating the sheet and the film, since the guide roll for introducing the film is arranged near the first or third roll, the film is brought into a little contact with the endless belt or the third roll, so that the thermoplastic resin film can be prevented from generating a wrinkle as much as possible.

[0021] In accordance with a second aspect of the present invention, there is provided a method of manufacturing a laminated thermoplastic resin sheet as recited in the first aspect, wherein the guide roll for introducing the film is arranged at a position at which an angle formed by a line between both centers of the first and third rolls and a contact point of the thermoplastic resin film with the endless belt or the third roll is 45 degrees or less.

20 [0022] When the contact portion between the thermoplastic resin film and the endless belt or the third roll is increased, a generation of the wrinkle is increased at the degree, so that the angle is set to be 45 degrees or less in order to prevent this as much as possible. The angle is preferably 30 degrees or less.

25 [0023] The object to be contacted is set to the endless belt or the third roll for the reason of corresponding to the case that the thermoplastic resin film is laminated on one surface (a front surface) or another surface (a back surface) of the thermoplastic resin sheet.

[0024] Here, in the present invention, a definition is made by the angle formed by a line between both centers of the first and third rolls and the contact point of the thermoplastic resin film with the endless belt or the third roll, however, a definition may be made by an introducing angle of the thermoplastic resin film to a nip portion (between the first and third cooling rolls) with respect to the line between both centers of the first and third rolls, and it is preferable as the angle is near 90 degrees.

30 [0025] In accordance with a third aspect of the present invention, there is provided a method of manufacturing a laminated thermoplastic resin sheet as stated in the first or second aspect, wherein a back tension 9.8 N/m to 294.0 N/m is applied to the thermoplastic resin film.

[0026] The back tension can be applied by adjusting a supply speed of supply means for the thermoplastic resin film.

[0027] In the case that the back tension is less than 9.8 N/m, an effect of sufficiently preventing a generation of a wrinkle and an effect of improving a stability in manufacturing can not be obtained. Further, when it is more than 294.0 N/m, there is a risk that the thermoplastic resin film extends so that a width of the film is narrowed.

40 [0028] In accordance with a fourth aspect of the present invention, there is provided a method of manufacturing a laminated thermoplastic resin sheet as stated in any one of the first to third inventions, wherein the thermoplastic resin film is laminated on each of the one surface and the another surface of the molten thermoplastic resin sheet through the guide roll for introducing the film.

[0029] That is, in accordance with the present invention, there can be obtained a laminated thermoplastic resin sheet structured to have at least three layers in which thermoplastic resin films are respectively laminated on an upper layer and a lower layer of the thermoplastic resin sheet as an intermediate layer.

45 [0030] In accordance with a fifth aspect of the present invention, there is provided an apparatus for manufacturing a laminated thermoplastic resin sheet, comprising a first cooling roll having a surface coated by an elastic material, a second roll, a metal endless belt wound between the first roll and the second roll, a third cooling roll brought into contact with the first cooling roll through the metal endless belt, molten resins supplying means arranged so as to introduce a thermoplastic resin sheet in a melting state between the first and third cooling rolls in such a manner as to be brought into contact with the metal endless belt contact with the first cooling roll and the third cooling roll substantially at the same time, and a guide roll for introducing the film arranged near the first or third roll so as to introduce a thermoplastic resin film between the metal endless belt and the third cooling roll.

50 [0031] The present invention corresponds to an apparatus for realizing the first invention.

[0032] In accordance with a sixth aspect of the present invention, there is provided an apparatus for manufacturing a laminated thermoplastic resin sheet as recited in the fifth aspect, wherein the guide roll for introducing the film is arranged at a position at which an angle formed by a line between both centers of the first and third rolls and a contact

point of the thermoplastic resin film with the endless belt or the third roll is 45 degrees or less.

[0033] The present invention corresponds to an apparatus for realizing the second invention.

[0034] In accordance with a seventh aspect of the present invention, there is provided an apparatus for manufacturing a laminated thermoplastic resin sheet as recited in the fifth or sixth aspect, wherein the guide roll for introducing the film  
5 is arranged in each of one surface and another surface of the molten thermoplastic resin sheet.

[0035] The present invention corresponds to an apparatus for realizing the fourth invention.

#### BRIEF DESCRIPTION OF THE DRAWING

10 [0036]

Fig. 1 is a schematic view of a manufacturing apparatus used in a method of manufacturing a laminated thermoplastic resin sheet in accordance with a first embodiment of the present invention.

15 DESCRIPTION OF THE PREFERRED EMBODIMENTS

[First embodiment]

[0037] At first, a structure of a manufacturing apparatus used in a method of manufacturing a laminated thermoplastic resin sheet 31 having a two layer structure in accordance with this embodiment will be described below with reference to Fig. 1.

[0038] The manufacturing apparatus is constituted by a T die 12 of an extruding machine for supplying a thermoplastic resin sheet 11, a metal endless belt 15 wound between a first and second rolls 12 and 13, a third roll 16 brought into contact with the first roll 13 through the metal endless belt 15, and a film supply roll 23 for supplying a formed thermoplastic resin film 22. Further, a fourth roll 21 for adjusting a tension and cooling in an auxiliary manner is provided within the endless belt 15.

[0039] The first roll 13 is structured such that an elastic member 18 such as a fluorine rubber or the like is coated on an outer peripheral surface thereof. The elastic material 18 is structured such that a hardness (on the basis of JIS K6301 A type) thereof is 95 degrees or less, and a thickness thereof is 3 mm or more.

[0040] The metal endless belt 15 is made of a stainless steel or the like, and is provided with a mirror surface having a surface roughness 0.5 S or less.

[0041] At least one of the first and second rolls 13 and 14 is structured such that a rotating shaft 19 thereof is connected to rotation drive means (not shown).

[0042] The third roll 16 is a metal roll, and is provided with a mirror surface having a surface roughness 0.5 S or less.

[0043] The third roll 16 is arranged at a position at which the metal endless belt 15 is held in a part of a peripheral surface thereof. That is, the metal endless belt 15 moves in a zigzag direction so as to wind around a part of the outer peripheral surface of the third roll 16.

[0044] Then, first and second guide rolls 24 and 25 for introducing the thermoplastic resin film are provided between the film supply roll 23 and a nip portion 26 (between the first and third cooling rolls 13 and 16).

[0045] The first guide roll 24 is arranged near the first roll 13. A distance between the first guide roll 24 and the nip portion 26 is preferably set to be 500 mm or less so as to prevent a wrinkle from generating. The guide roll 23 has a slight curve, and is an expander roll capable of removing a wrinkle.

[0046] Particularly, the first guide roll 24 is arranged at a position at which an angle  $\alpha$  formed by a line 27 between both centers of the first and third rolls 13 and 16 and a contact point of the thermoplastic resin film 22 with the endless belt 15 is 45 degrees or less.

[0047] Further, a back tension 9.8 N/m to 294.0 N/m is applied to the thermoplastic resin film 22 by controlling a rotation of the film supply roll 23.

[0048] The second guide roll 25 is provided at a suitable position in the side of the film supply roll 23.

[0049] Temperature adjusting means (not shown) of a water cooling type or the like capable of adjusting a temperature of the surface is provided in each of the rolls 13, 14, 16 and 21.

[0050] Next, a manufacturing method in accordance with this embodiment using the manufacturing apparatus will be described below.

[0051] As well as the molten thermoplastic resin sheet 11 extruded out from the T die 12 of the extruding machine is introduced to the nip portion 26 between the first and third rolls 13 and 16, the thermoplastic resin film 22 extruded out from the film supply roll 23 is introduced to the nip portion 26 through the first guide roll 24, so that the sheet 11 and the film 22 are laminated and cooled at the same time.

[0052] At this time, the elastic material 18 elastically deforms in such a manner as to be compressed by a pressing force between the first and third rolls 13 and 16, and the sheet 11 and the film 22 is in a plane pressure contact state.

by both rolls 13 and 16 at a portion having an angle  $\theta 1$  from a center of both rolls 13 and 16 at which the elastic member 18 is elastically deformed.

[0053] Continuously, the laminated thermoplastic resin sheet 31 is pressed to the third roll 16 by the endless belt 15 and cooled. The laminated thermoplastic resin sheet 31 pressed to the roll 16 by the endless belt 15 is held to the roll

5 16 at an angle  $\theta 2$  from a center of the roll 16, and the laminated thermoplastic resin sheet 31 is pressed in a plane manner at the portion having the holding angle  $\theta 2$  by the endless belt 15 and the third roll 16.

[0054] Next, the laminated thermoplastic resin sheet 31 is removed from the endless belt 15, and taken up to a take-up roll (not shown) through the guide roll 17.

[0055] In this case, the structure may be made such that the guide roll 17 is provided near the second roll 14, the 10 laminated thermoplastic resin sheet 31 closely attached to the endless belt 15 is moved to the second roll 14 in accordance with a rotation of the endless belt 15, and a further cooling is performed by the second roll 14.

[0056] In accordance with this embodiment, at the portion having the angle  $\theta 1$  of the first and third rolls 13 and 16, since the sheet 11 and the film 22 are pressed in a plane pressure manner and cooled at the same time when the sheet 11 and the film 22 are laminated by the rolls 13 and 16 and the endless belt 15 while elastically deforming the elastic member 18, a bonding strength of the laminated thermoplastic resin sheet 31 is improved.

[0057] Then, since the thermoplastic resin film 22 is introduced to the nip portion 26 through the first guide roll 24 for introducing the film at a time of laminating the sheet 11 and the film 22, a contact portion of the thermoplastic resin film 22 with the endless belt 15 is reduced, and a generation of a wrinkle in the thermoplastic resin film 22 can be prevented, so that the laminated thermoplastic resin sheet 31 without a wrinkle can be obtained.

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#### [Second embodiment]

[0058] In the first embodiment, the structure is made such that the thermoplastic resin film 22 is laminated on one 25 surface of the thermoplastic resin sheet 11. As shown by two dot chain line in Fig. 1, in accordance with this embodiment, the structure is made such that a film supply roll 23 for supplying another thermoplastic resin film 22 and first and second guide rolls 24 and 25 for introducing the thermoplastic resin film are further provided on the back of the thermoplastic resin sheet 11, so that the thermoplastic resin film 22 can be laminated on both surfaces of the thermoplastic resin sheet 11.

[0059] Also in this case, the first guide roll 24 for introducing the another thermoplastic resin film is arranged at a position 30 at which the angle  $\alpha$  formed by the line 27 between both centers of the first and third rolls 13 and 16 and the contact point of the thermoplastic resin film 22 with the third roll 16 is 45 degrees or less.

### EXAMPLES

#### 35 [Example 1]

[0060] In the first embodiment mentioned above, a laminated thermoplastic resin sheet is manufactured by setting particular conditions of a manufacturing apparatus and a manufacturing method as follows.

40 Diameter of first to fourth rolls... 400 mm

Elastic member of first roll ... silicone rubber, thickness: 10 mm, hardness: 40 degrees

surface temperature of first roll ... 20 °C

Surface temperature of second roll ... 20 °C

Surface temperature of third roll ... 20 °C

45 Angle  $\alpha$  ... 10 degrees

Metal endless belt ... thickness: 0.8 mm, speed: 25 m/min

Thermoplastic resin sheet ... polypropylene sheet [IDEMITSU POLYPRO F-205S produced by IDEMITSU Petrochemical Co., Ltd]

Thermoplastic resin film ... three layer structure of polypropylene (30 µm)/EVOH (30 µm)/polypropylene (30 µm)

50 Tension of thermoplastic resin film ... 50.0 N/m

Laminated thermoplastic resin sheet ... thickness: 0.3 mm, width: 1200 mm

#### [Example 2]

55 [0061] In the example 1, only the angle  $\alpha$  and the tension of the thermoplastic resin film are changed.

Angle  $\alpha$  ... 20 degrees

Tension of thermoplastic resin film ... 30.0 N/m

## [Example 3]

[0062] In the example 1, only the angle  $\alpha$  and the tension of the thermoplastic resin film are changed.

5      Angle  $\alpha$  ... 30 degrees  
 Tension of thermoplastic resin film ... 50.0 N/m

## [Example 4]

10     [0063] In the example 1, only the angle  $\alpha$  and the tension of the thermoplastic resin film are changed.

Angle  $\alpha$  ... 40 degrees  
 Tension of thermoplastic resin film ... 50.0 N/m

## 15     [comparative examples 1 to 3]

[0064] In the case of a comparative example 1, the first guide roll for introducing the film is not provided in the apparatus in accordance with the example 1, and the angle  $\alpha$  is 60 degrees.

20     [0065] In the case of a comparative example 2, in the example 1, only the tension of the thermoplastic resin film is changed to 400.0 N/m.

[0066] In the case of a comparative example 2, the laminated thermoplastic resin sheet the same as the example 1 is manufactured in accordance with coextrusion method. A used adhesive is Admer QB550 (trade name).

## 25     [Estimation of characteristics]

[0067] With respect to the laminated thermoplastic resin sheets obtained in the examples and the comparative examples mentioned above, whether or not a wrinkle is generated is checked, and also a haze and a gloss are measured. The results thereof are shown in Table 1.

30     [0068] The haze and gloss are measured in accordance with JIS K 7105.

Table 1

	Angle $\alpha$	Tension (N/m)	Speed (m/min)	Haze (%) [total/inner portion]	Gloss	Wrinkle
Example 1	10	50.0	25	2.0/1.3	140	No
Example 2	20	30.0	25	1.7/1.2	140	No
Example 3	30	50.0	25	1.9/1.3	140	No
Example 4	40	50.0	25	2.1/1.2	140	No
Comparative example 1	60	50.0	25	1.9/1.4	-	Yes
Comparative example 2	20	400	25	1.8/1.3	140	No
Comparative example 3	-	-	25	6.3/5.7	135	-

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[0069] As shown in Table 1, in accordance with the examples 1 to 4, since the thermoplastic resin film 22 is introduced

to the nip portion 26 through the first guide roll 24 for introducing the film at a time laminating the thermoplastic resin sheet 11 and the thermoplastic resin film 22, the laminated thermoplastic resin sheet 31 having a good haze and gloss can be obtained.

[0070] Further, a generation of a wrinkle is not appeared in the obtained laminated thermoplastic resin sheet 31.

5 [0071] On the contrary, in accordance with the comparative example 1, since the first guide toll for introducing the film is not provided, a contact length of the thermoplastic resin film with the endless belt 15 is too long so that a wrinkle is generated in the laminated thermoplastic resin sheet.

[0072] In accordance with the comparative example 2, although the first guide roll for introducing the film is provided, the back tension is too large, so that the thermoplastic resin film is extended so as to make it hard to control a width thereof.

[0073] In accordance with the comparative example 3, since the laminated thermoplastic resin sheet is manufactured by a coextrusion method, the obtained laminated thermoplastic resin sheet has a high haze and is deteriorated in a transparency.

[0074] In accordance with the method of manufacturing the laminated thermoplastic resin sheet and the apparatus therefore of the present invention, the laminated thermoplastic resin sheet having an improved transparency can be manufactured without generating a wrinkle.

### Claims

- 20 1. A method of manufacturing a laminated thermoplastic resin sheet, which uses a manufacturing apparatus comprising a first cooling roll having a surface coated by an elastic material, a second roll, a metal endless belt wound between the first roll and the second roll and a third cooling roll brought into contact with the first cooling roll through said metal endless belt, comprising steps of: arranging a guide roll for introducing a film near said first or third roll so as to introduce a thermoplastic resin sheet in a melting state between the first and third cooling rolls in such a manner as to be brought into contact with said metal endless belt contact with said first cooling roll and said third cooling roll substantially at the same time; introducing a thermoplastic resin film between said metal endless belt and said third cooling roll through said guide roll so as to laminate the sheet and the film; pressing and cooling said laminated thermoplastic resin sheet in a plane manner by said first and third rolls while elastically deforming said elastic material by a pressing force between said first and third rolls; and continuously pressing and cooling said laminated thermoplastic resin sheet to the third cooling roll in a plane manner by said endless belt.
- 25 2. A method of manufacturing a laminated thermoplastic resin sheet as claimed in claim 1, wherein said guide roll for introducing the film is arranged at a position at which an angle formed by a line between both centers of the first and third rolls and a contact point of said thermoplastic resin film with said endless belt or the third roll is 45 degrees or less.
- 30 3. A method of manufacturing a laminated thermoplastic resin sheet as claimed in claim 1 or 2, wherein a back tension 9.8 N/m to 294.0 N/m is applied to said thermoplastic resin film.
- 35 4. A method of manufacturing a laminated thermoplastic resin sheet as claimed in any one of claims 1 to 3, wherein said thermoplastic resin film is laminated on each of the one surface and the another surface of said molten thermoplastic resin sheet through said guide roll for introducing the film.
- 40 5. An apparatus for manufacturing a laminated thermoplastic resin sheet, comprising;
  - 45 a first cooling roll having a surface coated by an elastic material, a second roll, a metal endless belt wound between the first roll and the second roll;
  - 50 a third cooling roll brought into contact with the first cooling roll through said metal endless belt; molten resin supplying means arranged so as to introduce a thermoplastic resin sheet in a melting state between the first and third cooling rolls in such a manner as to be brought into contact with said metal endless belt contact with said first cooling roll and said third cooling roll substantially at the same time; and a guide roll for introducing the film arranged near said first or third roll so as to introduce a thermoplastic resin film between said metal endless belt and said third cooling roll.
- 55 6. An apparatus for manufacturing a laminated thermoplastic resin sheet as claimed in claim 5, wherein said guide roll for introducing the film is arranged at a position at which an angle formed by a line between both centers of the first and third rolls and a contact point of said thermoplastic resin film with said endless belt or the third roll is 45 degrees or less.

7. An apparatus for manufacturing a laminated thermoplastic resin sheet as claimed in claim 5 or 6, wherein said guide roll for introducing the film is arranged in each of one surface and another surface of said molten thermoplastic resin sheet.

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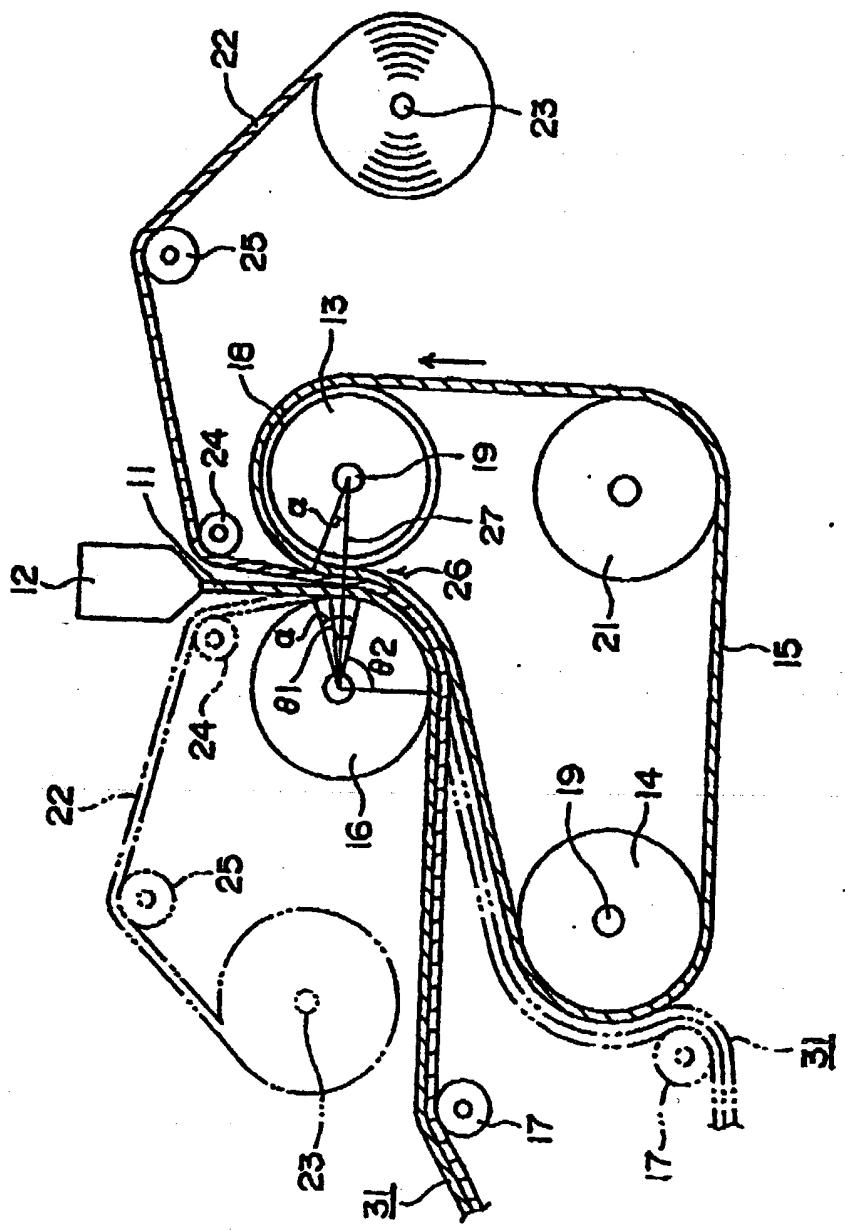


Figure 1